PATENT SPECIFICATION

774,059

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The inventor of this invention in the sense of being the actual deviser thereof within the meaning of Section 16 of the Patents Act, 1949 is MICHEL ROBERT GARNIER, a French citizen, of 72 Avenue de la Republique, Le Plessis-Robinson Seine, France.

COMPLETE SPECIFICATION

Improvements in or relating to Combined Gas Turbine Plant and Ram-Jet Units

We, SOCIETE NATIONALE D'ETUDE ET DE CONSTRUCTION DE MOTEURS D'AVIATION, a French Body Corporate, of 150 Boulevard Haussmann, Paris, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which in is to be performed, to be particularly described in and by the following statement:—

In ram-jets, it is known that slowing down of air in the combustion chamber, which is accompanied by an increase of pressure, is obtained by a suitable design of the air intake. This duct has ahead of the combustion chamber a divergent part acting as a diffuser.

However, at high altitudes, the absolute pressure in the combustion chamber and the air temperature go down to such a point that it is impossible to get a good combustion and unexpected extinctions have been observed.

The present invention permits to overcome this difficulty and to increase the highest altitude at which the ram-jet can still work satisfactorily.

In accordance with this invention, a composite gas turbine plant and ram-jet unit is characterised in that one or more auxiliary combustion chambers of relatively small volume are arranged inside the main combustion chamber of the ram-jet unit and communicate with said main chamber through orifices facing in a direction substantially inclined with respect to the flow direction of the stream through the ram-jet unit, said auxiliary combustion chamber or chambers being fed with fuel and with air tapped from the compressor of the gas turbine plant or other part thereof wherein the pressure is substantially greater than the pressure obtaining in the main combustion chamber of the ram-jet unit.

The invention is illustrated by way of example in the accompanying drawings in which:—

Figs. 1 and 2 are longitudinal sections of two embodiments of the invention.

On Fig. 1, we see, at 1, the air intake duct of the ram-jet which slows down the velocity of the air going through the aperture 2 and increases the air pressure; at 3 the centre part wherein the velocity is slowed down and wherein the combustion of the injected fuel must be done; finally, at 5, the expansion nozzle giving the propelling jet.

Auxiliary combustion chambers 6 having a small volume and a faired shape are located in the combustion chamber 3. They are distributed around the ram-jet centreline. Each of these chambers has a nozzle 7 by which fuel is injected and receives through a duct 8 the combustion air under a fairly high pressure from an air compressor 9. This air compressor is part of a turbo-jet engine including the combustion chambers 10, the gas turbine 11 which drives the air compressor 9, and the expansion nozzle 12, an after-burning chamber 13 with its injectors 14 being advantageously placed between the turbine 11 and the nozzle 12. Good combustion can be obtained in the auxiliary chambers 6, even for altitudes at which the pressure and the temperature of the ambient air are insufficient for a good combustion of the fuel injected at 4 into the ram-jet chamber 3. Indeed these chambers are fed under the same pressure as the gas turbine combustion chambers 10 and it suffices to provide a compressor 9 giving a compression ratio adapted to the desired altitude ceiling.

Exhaust of the combustion gases from the chambers 6 is made through the holes 15 facing in a direction substantially inclined with respect to the flow direction of the stream through the ram-jet unit and so located that the very hot gases coming from the chambers 6 go into the part of the ram-jet chamber 3 wherein the combustion must be done. On

the attached drawing example, the combustion chambers 6 are located downstream of the injectors 4. The exhaust holes 15 are arranged on the upstream side of the combustion chambers 6 and the air which goes through the ram-jet is strongly heated by the gases coming from the chambers 6. Thus, this facilitates the combustion of the fuel injected at 4 ahead of the conventional flame holders 4*a*. Furthermore combustion chambers 6 and the supporting radial arms 6*a* make wakes in the flow of the air which goes through the ram-jet engine and thus help the combustion of the fuel supplied by the injectors 4. In view of this, it is preferable to locate these chambers downstream of the injectors 4, as shown in the drawing.

The total amount of heat produced in the ram-jet comes from the combustion of the fuel feeding the injectors 4 and 7 respectively. It is therefore possible to control this total amount of heat by acting on the respective flows of the injectors 4 and 7. The flow of the injectors 7 being only a fraction of the flow sent to the injectors 4 under full rating conditions.

It is also possible to conceive another method of operation of the ram-jet in which the total fuel flow necessary for the operation of the said ram-jet under certain rating conditions is supplied to the injectors 7, the flow sent to the injectors 4 being only a make up flow that can be increased as the ram-jet power output increases.

The presence of the chambers 6 also facilitates ignition of the ram-jet when a certain flying speed is reached under the action of the turbo-jet engine working first alone. As a matter of fact, ignition in the chambers 6 will be easy through the usual means and these chambers, when ignited, will ignite in turn the combustion in the ram-jet chamber 3 when the fuel is supplied to the injectors 4.

Ducts 8 can be provided advantageously with valves 8*a* which can be closed when the turbo-jet engine is working alone, for example when taking off or when cruising slowly.

To increase the altitude at which combustion is well performed in the chambers 6 and 10, it is possible to provide in the turbo-jet chambers 10 auxiliary chambers similar to the chambers 6 and to feed those auxiliary chambers as well as the chambers 6 with air coming from one or several additional compression stages working on part of the air delivered by the main compressor 9. The additional compression stages can be driven by a mechanical device connected to the turbine 11 or by a small auxiliary gas turbine.

In the embodiment shown on Fig. 1, the turbo-jet engine is set upon the ram-jet axis and its expansion nozzle 12 smaller than the ram-jet expansion nozzle 5 throws out its jet through the nozzle 5.

In this manner a very compact arrangement is obtained which has the advantages of the turbo-jet for take off and those of the ram-jet for reaching high flying speeds while permitting to increase the ram-jet altitude ceiling.

The embodiment of Figure 2 is different from the former in that the turbo-jet is outside of the ram-jet (placed and attached below it, for example). This permits the use of a ram-jet air intake which has a centre body 16 faired for supersonic speeds. In this case the exhaust nozzles of the two machines are separate, and this allows the provision of an area-varying device for the turbo-jet exhaust nozzle alone. Such a device has been shown on attached drawing in the form of two pivotal flaps 17.

Of course, the separate auxiliary chambers 6 can be replaced by a single annular combustion chamber.

What we claim is:—

1. A composite gas turbine plant and ram-jet unit characterised in that one or more auxiliary combustion chambers of relatively small volume are arranged inside the main combustion chamber of the ram-jet unit and communicate with said main chamber through orifices facing in a direction substantially inclined with respect to the flow direction of the stream through the ram-jet unit, said auxiliary combustion chamber or chambers being fed with fuel and with air tapped from the compressor of the gas turbine plant or other part thereof wherein the pressure is substantially greater than the pressure obtaining in the main combustion chamber of the ram-jet unit.

2. Unit as claimed in claim 1, characterised in that the auxiliary combustion chamber or chambers are positioned downstream of the main fuel injectors of the ram-jet unit and of the flame holders associated therewith when such flame holders are provided.

3. Unit as claimed in claim 1 or 2, characterised in that the gas turbine plant is a turbo-jet unit ending with an exhaust nozzle having its axis coincident with or parallel to the axis of the ram-jet unit.

4. Unit as claimed in claim 3, characterised in that the turbo-jet unit extends adjacent to but outside the ram-jet unit in parallel relation therewith, said ram-jet unit having a central body ending forwardly with an acute supersonic nose and said turbo-jet unit having a variable-area propelling nozzle.

5. A composite gas-turbine plant and ram-jet unit constructed and arranged substantially as herein described with reference to Figure 1 or Figure 2 of the accompanying drawings.

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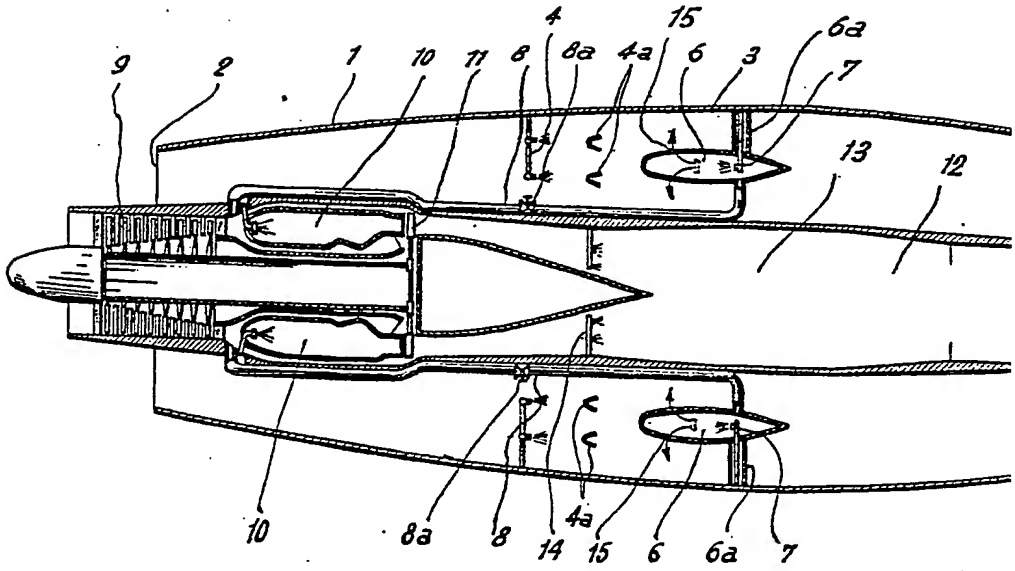
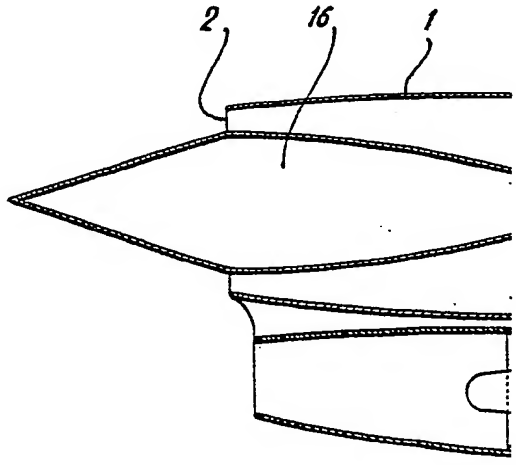
Fig: 1





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This drawing is a reproduction of the Original on a reduced scale.

Fig: 1

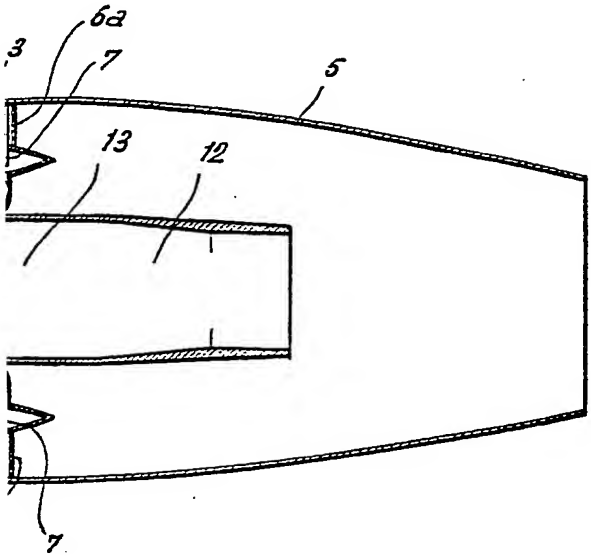

Fig: 2

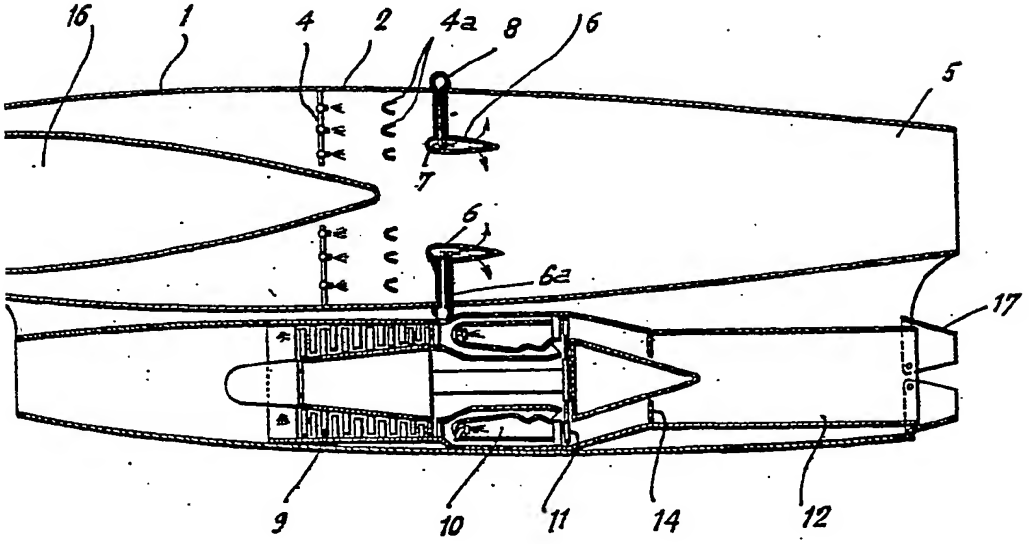

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Fig. 1

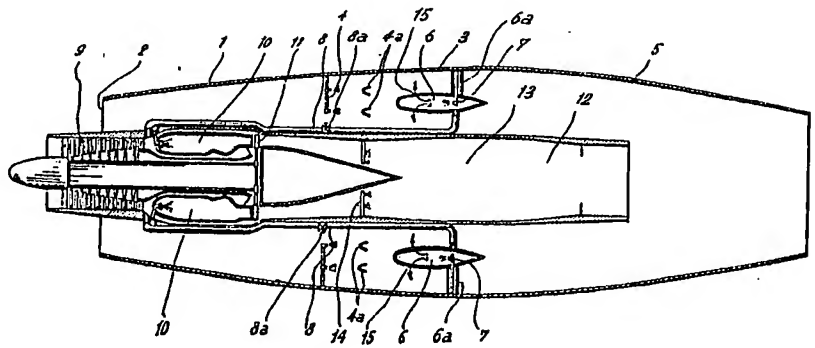

Fig. 2